Amendments to the Claims

The following listing of claims will replace all prior versions, and listings, of claims in the present application:

1. (Currently Amended) A system for actively damping ~~the~~ low-frequency coloration of sound comprising:

a listening room including a sound source, said listening room defining at least one mode of low-frequency coloration attributable to said listening room ~~sound source~~;

an acoustic wave sensor positioned within said listening room, wherein said acoustic wave sensor is operative to produce a first signal representative of said at least one mode of low-frequency coloration;

an acoustic wave actuator responsive to a second signal and positioned within said listening room~~, wherein said acoustic wave actuator is substantially collocated with said acoustic wave sensor~~; and

an electronic feedback controller defining an input coupled to said first signal and an output, wherein

said electronic feedback controller is operative to generate said second signal at said output by applying a feedback controller transfer function to said first signal,

said feedback controller transfer function comprises a second order differential equation including a first variable representing a predetermined damping ratio and a second variable representing a tuned natural frequency,

said second variable representing said tuned natural frequency is selected to be tuned to said at least one mode of low-frequency coloration,

said feedback controller transfer function defines a frequency response having a characteristic maximum gain substantially corresponding to the value of said at least one mode of low-frequency coloration, ~~and wherein~~

said feedback controller transfer function creates a 90 degree phase lead substantially at said at least one mode of low-frequency coloration,

said feedback controller transfer function is augmented by the inverse of an acoustic wave actuator transfer function of said acoustic wave actuator to produce an augmented feedback controller transfer function, and

said augmented feedback controller transfer function is as follows:

$$\frac{V(s)}{P(s)} = G\frac{s^2 + 2\varsigma_s\omega_s s + \omega_s{}^2}{s^2 + 2\varsigma\omega_n s + \omega_n{}^2}$$

where the units of $V(s)$ corresponds to said rate of change of volume velocity, $P(s)$ corresponds to the pressure at the location of said acoustic wave sensor and said acoustic wave actuator, s is the Laplace variable, ς represents a damping ratio of an acoustic damping controller, ς_s represents a damping ratio of said acoustic wave actuator, ω_n is said tuned natural frequency, ω_s is a natural frequency of said acoustic wave actuator, and G is a gain value.

2. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said first signal represents pressure sensed by said acoustic wave sensor and said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator.

3. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein

said first signal represents pressure sensed by said acoustic wave sensor,

said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator, and wherein

said feedback controller transfer function is as follows:

$$\frac{V(s)}{P(s)} = G\frac{s^2}{s^2 + 2\xi\omega_n s + \omega_n^2}.$$

where the units of $V(s)$ corresponds to said rate of change of volume velocity, $P(s)$ corresponds to the pressure at the location of said acoustic wave sensor and said acoustic wave actuator, s is the Laplace variable, ξ is a damping ratio, ω_n is said tuned natural frequency, and G is a gain value.

4-5. (Canceled)

6. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein

said first signal represents pressure sensed by said acoustic wave sensor,

said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator~~,~~

~~said feedback controllertransfer function is augmented by the inverse of an acoustic wave actuator transfer function of said acoustic wave actuator to produce an augmented feedback controller transfer function, and wherein~~

~~said augmented feedback controller transfer function is as follows:~~

$$[[\cancel{\frac{V(s)}{P(s)} = G\frac{s^2 + 2\varsigma_s\omega_s s + \omega_s^2}{s^2 + 2\varsigma\omega_n s + \omega_n^2}} \qquad \cancel{(3')}]]$$

~~where the units of $V(s)$ corresponds to said rate of change of volume velocity, $P(s)$ corresponds to the pressure at the location of said acoustic wave sensor and said acoustic wave actuator, s is the Laplace variable, ς represents a damping ratio of an acoustic damping controller, ς_n represents a damping ratio of said acoustic wave actuator, ω_n is said tuned natural frequency, ω_s is a natural frequency of said acoustic wave actuator, and G is a gain value.~~

7. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said feedback controller transfer function defines a frequency response and wherein the gain of said frequency response increases substantially uniformly from a minimum frequency value to an intermediate frequency value to define a

characteristic maximum gain and decreases substantially uniformly from said intermediate frequency value to a maximum frequency value.

8. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 7 wherein said intermediate frequency value corresponds to said at least one mode of low-frequency coloration.

9. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said first variable representing said predetermined damping ratio is a value between about 0.1 and about 0.35.

10. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said first variable representing said predetermined damping ratio and said second variable representing said tuned natural frequency are selected to damp said at least one mode of low-frequency coloration.

11. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said second variable representing said tuned natural frequency is selected to be substantially equivalent to a natural frequency of a target acoustic mode of said at least one mode of low-frequency coloration.

12. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 11 wherein said target acoustic mode comprises the lowest frequency audible mode of low-frequency coloration.

13. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said second variable representing said tuned natural frequency is selected to be a value between adjacent frequency modes.

14. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said electronic feedback controller is further operative to invert the phase of said second signal.

15. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave actuator introduces characteristic acoustic dynamics into said system and wherein said electronic feedback controller is operative to introduce inverse actuator dynamics into the system.

16. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein

said electronic feedback controller comprises an acoustic damping controller programmed to apply said feedback controller transfer function, and wherein

said acoustic damping controller is configured to selectively damp or treat greater than one frequency mode of coloration.

17. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 16 wherein said acoustic damping controller is positioned within said listening room ~~enclosure~~.

18. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said first signal and said second signal comprise respective electric signals.

19. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave actuator and said acoustic wave sensor are positioned to correspond to the location of an acoustic anti-node of a target acoustic mode within said listening room.

20. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave sensor is a microphone.

21. (Currently Amended) The ~~A~~ system for actively damping the low-frequency coloration of sound as claimed in claim 1 wherein said acoustic wave actuator is a subwoofer.

22-24 (Canceled).

25. (Currently Amended) A system for actively damping the low-frequency coloration of sound comprising:

a listening room including a sound source, said listening room defining at least one mode of low-frequency coloration attributable to said sound source;

an acoustic wave sensor positioned within said listening room, wherein said acoustic wave sensor is operative to produce a first signal representative of said at least one mode of low-frequency coloration, and wherein said first signal represents pressure sensed by said acoustic wave sensor;

an acoustic wave actuator responsive to a second signal and positioned within said listening room, wherein said acoustic wave actuator is substantially collocated with said acoustic wave sensor, wherein said second signal represents a rate of change of volume velocity to be produced by said acoustic wave actuator, and wherein said acoustic wave actuator introduces acoustic dynamics into said system; and

an electronic feedback controller defining an input coupled to said first signal and an output, wherein

said electronic feedback controller is operative to generate said second signal at said output by applying a feedback controller transfer function to said first signal, invert the phase of said second signal, and to introduce inverted actuator acoustic dynamics into said second signal,

said feedback controller transfer function comprises a second order differential equation including a first variable representing a predetermined damping ratio and a second variable representing a tuned natural frequency,

said second variable representing said tuned natural frequency is selected to be tuned to said at least one mode of low-frequency coloration, and wherein

said feedback controller transfer function is as follows ~~selected from the group consisting of~~

$$\frac{V(s)}{P(s)} = G\frac{s^2}{s^2 + 2\xi\omega_n s + \omega_n^2} \qquad \cancel{(1)},$$

$$[[\cancel{\frac{V(s)}{P(s)} = G\frac{s}{s^2 + 2\xi\omega_n s + \omega_n^2} \qquad (2), \text{and}}]]$$

$$[[\cancel{\frac{V(s)}{P(s)} = G\frac{s(s+a)}{s^2 + 2\xi\omega_n s + \omega_n^2} \qquad (3)}]]$$

where the units of *V(s)* corresponds to said rate of change of volume velocity, *P(s)* corresponds to the pressure at the location of said acoustic wave actuator and said acoustic wave sensor, *a* represents a weighting factor, ξ is a damping ratio, ω_n is said tuned natural frequency, and *G* is a gain value,

said feedback controller transfer function defines a frequency response having a characteristic maximum gain substantially corresponding to the value of said at least one mode of low-frequency coloration,

said feedback controller transfer function creates a 90 degree phase lead substantially at said at least one mode of low-frequency coloration,

~~said feedback controller transfer function defines a frequency response having a gain that increases substantially uniformly from a minimum frequency value to an intermediate frequency value to define a characteristic maximum gain and decreases substantially uniformly from said intermediate frequency value to a maximum frequency value, and wherein~~

said intermediate frequency value corresponds to said at least one mode of low-frequency coloration, and

said feedback controller transfer function is augmented by the inverse of an acoustic wave actuator transfer function of said acoustic wave actuator to produce an augmented feedback controller transfer function, and

said augmented feedback controller transfer function is as follows:

$$\frac{V(s)}{P(s)} = G\frac{s^2 + 2\varsigma_s \omega_s s + \omega_s^{\ 2}}{s^2 + 2\varsigma \omega_n s + \omega_n^{\ 2}}$$

where the units of *V(s)* corresponds to said rate of change of volume velocity, *P(s)* corresponds to the pressure at the location of said acoustic wave sensor and said acoustic wave actuator, s is the Laplace variable, ς represents a damping ratio of an acoustic damping controller, ς_s represents a damping ratio of said acoustic wave actuator, ω_n is said tuned natural frequency, ω_s is a natural frequency of said acoustic wave actuator, and G is a gain value.

26. (Canceled)

27. (Currently Amended) A system for actively treating noise within a fluid-carrying duct comprising:

a fluid-carrying duct;

a source of acoustical disturbance within said fluid-carrying duct, wherein said acoustical disturbance defines at least one frequency of disturbance within said fluid-carrying duct;

an acoustic wave sensor positioned to sense fluid pressure within said duct, wherein said acoustic wave sensor is operative to produce a first signal representative of said frequency of disturbance;

an acoustic wave actuator positioned to manipulate fluid within the duct, wherein said acoustic wave actuator is substantially collocated with said acoustic wave sensor; and

an electronic feedback controller defining an input coupled to said first signal and an output, wherein

said electronic feedback controller is operative to generate said second signal at said output by applying a feedback controller transfer function to said first signal,

said feedback controller transfer function comprises a transfer function simulating (i) a low pass acoustic filter of the form $LP = Cs^2$ where C represents compliance of the simulated low pass filter and s is the Laplace variable, (ii) a high pass acoustic filter of the form HP=1/L, where L represents inertance of the simulated high pass acoustic filter, or (iii) a passive, band-reject, acoustic filter comprising a second order differential equation including a first variable representing a predetermined damping ~~damping/treating~~ ratio and a second variable representing a tuned natural frequency,

said second variable representing said tuned natural frequency is selected to be tuned to said frequency of disturbance, and

said feedback controller transfer function defines a frequency response having a characteristic maximum gain substantially corresponding to the value of said frequency of disturbance.

28. (Currently Amended) The ~~A~~ system for actively treating noise within a fluid-carrying duct as claimed in claim 27 wherein the fluid-carrying duct is selected from the group consisting of liquid-carrying ducts, gas-carrying ducts, and combinations thereof.

29. (Currently Amended) The ~~A~~ system for actively treating noise within a fluid-carrying duct as claimed in claim 27 wherein said acoustic wave sensor is a microphone and said acoustic wave actuator comprises a speaker ~~is a subwoofer~~.

30. (Currently Amended) The ~~A~~ system for actively treating noise within a fluid-carrying duct as claimed in claim 27 wherein said acoustic wave sensor is a pressure sensor and said acoustic wave actuator comprises a modulated diaphragm ~~is a diaphragm modulated by an electrical or hydraulic drive~~.

31. (Currently Amended) The ~~A~~ system for actively treating noise within a fluid-carrying duct as claimed in claim 27 wherein said system is employed in air-conditioning ducts, industrial exhaust stacks and engine intake and exhaust apparatus, or pulsation abatement in liquid-carrying lines.

32-35. (Canceled)

36. (New) A system for actively treating noise within a fluid-carrying duct as claimed in claim 27 said feedback controller transfer function comprises a combination of two or more of said low pass acoustic filter, said high pass acoustic filter, and said passive, band-reject, acoustic filter.